# DANCING IN VIRTUAL REALITY

An Undergraduate Research Scholars Thesis

by

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# TABLE OF CONTENTS

# ABSTRACT

Dancing in Virtual Reality

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This creative project serves to explore the fields of choreography, lighting and music design, and virtual reality technology to create a performance piece. There is a growing surge of advances in virtual reality technology, and in order to keep the field of dance innovative and the discussion between the worlds of dance and technology relevant, we are interested in merging the two in a collaborative work. It is important to continue to present dance to audiences using different means to help achieve an experience for the audience and explore creative options in our own choreography. The overall goal of this research is to create an interesting modern dance performance that incorporates virtual reality technology. Our end result will be accomplished by dividing the work into three separate parts. Each team member will then focus on their area of the project. The first area is the dance choreography which will be entirely in a modern dance vernacular. The second aspect is the lighting and music design. The music will be chosen to set the mood of the piece, and the lighting will have to be enough to light the dancer, yet not over power the projections on the screen. The third aspect is the virtual reality aspect. The technology has been designed by the visualization department in collaboration with the dancers. The combination of these three aspects will form a performance piece that will be presented to audiences of various backgrounds.

# SECTION I

# OVERVIEW OF VIRTUAL REALITY PERFORMANCE

The purpose of this study is to explore the different possibilities when combining dance, virtual reality technology, music, lighting, and costumes to create a performance. The importance of this research is to entertain audiences, create a thought provoking piece, and use difference means to accomplish it. As choreographers, we are often faced with the challenge of incorporating dance, music and costumes and making them work together harmoniously. With adding in this extra element of technology it will add a new choreographic challenge.

The technology we are using is virtual reality equipment. The difference between a traditional dance performance and a performance incorporated with technology is that "with virtual reality, one's attention can be guided in subtle ways by lighting cues, directional sound and mass movement to one side" (Perkovic). There are goggles that the performer will wear allowing them to only see the images they create. They create these images using two controllers that will be sewn into their costumes, which also correspond to the goggles. The motion sensor controllers will be located on the dancer's wrists and as the dancer moves each arm, an image will be displayed. All of the images are projected on a mesh screen in front of the dancer, so essentially the dancer will be performing behind the images that they are controlling. This screen will allow for audiences to not only see the animated images designed by the visualization department, but they are also still able to view the dancer and her movements behind the scrim. This project is "an illusion, created by an elaborately engineered virtual reality system that could begin to replace traditional sets with projectors, screens and computers" (Stinson).

A dance and virtual reality collaboration took place between the Australian Center for the Moving Image (Acmi) and the Sydney Dance Company resulting in a " short in duration [film] and dappled with the occasional video freeze – [that was] a spectacular demonstration of what dance, film and theatre could become in the future of virtual reality" (Perkovic). The difference between the film produced in Australia and this research study is that our final showing will happen live. With a live showing, there is always an element of variation with the dancers and the images viewed by the audiences versus a filmed project where everything can be controlled. The design and shapes displayed on the scrim vary between movements as well as the force and quality of movement performed by the dancer. The virtual reality equipment is sensitive and therefore there will always be a difference in the images that are displayed just by how the dancer moves in each performance of this piece. If the dancer's motions are too jagged, the images will be displayed as sharp linear animations that also become brighter. Understanding how the virtual reality equipment responds to certain movements, allows for us to establish the quality of movement necessary to create a choreographic piece with various dynamics. However, even though we have created movement to complement the virtual reality images displayed, there will continue to be an element of surprise for each performance of this work due to variation in the dancer's movements.

**Project Description**

This choreographic work will demonstrate the use of dance and technology to explore the expanding idea of what the modern population is being captured by in the performing arts. We plan to accomplish this goal through collaboration with the visualization department to work together to merge our areas of interest. Weekly meetings will occur with the visualization department to keep to the agenda with the updates in the technology equipment, as well as

weekly rehearsals with the dancers to generate movement and develop the choreography of the piece. The majority of our choreographic vocabulary will be influenced by the virtual reality equipment including the sensors that the dancer will wear around their wrists, the headset that will allow the dancer to see the images being displayed, and the chord attaching the headset to the computer. These props will determine where the dancer can go on the stage, and what they can do. The chord will be the limiting factor in radius that the dancer can use, and the headsets and sensors will determine the amount of movement the dancer can most efficiently perform. Another factor that will influence the choreography is the images being projected in front of the dancer. In order for the shapes to show up on the screen, the dancer will have to move in a way that these shapes are formed. If the movement is too small or too detailed, the images on the screen would not be able to be seen. These limitations will actually be positive when exploring the creation process of the dance, since we will have to work around these obstacles and think of innovative movement that will still translate as modern dance performance on stage. The framework of this experimental process will involve three main components that will each be designed by a different person. Together these components will be pieced together to create the work.

**Virtual Reality Technology**

The first component is surrounded by the Virtual Reality technology that has been previously designed by the Texas A&M Visualization Program. This technology includes Virtual reality goggles that one person; the dancer, will wear and a controller that create lines or shapes in accordance with her movement that will be projected on a screen for the audience. The exploration of this component will include discovering through trial and error and through visual exploration, how the technology works and what pictures that the remote creates on a screen for

the audience as well as how these correspond with the location of the dancer in the space for the designated virtual reality. Kali Taft will be focusing on the virtual reality equipment for this research study, and writing about it and communicating with the technology creators about ideas and ways to integrate the technology with the other aspects of the performance.

**Choreography**

The second component to this study involves the choreography of the dancer. Hannah Juenke will be in close communication with the researcher in charge of learning the technology because the information that is learned will allow the choreographer to specifically create a set of movement patterns or a general structure to a piece that will be performed in front of an audience. For Hannah's portion of this creative process, she will be in charge of creating the dancer's choreographic vocabulary. A majority of the movements will be designed based on the shapes created by the controllers, which play an important role in the overall portrayal of the virtual reality technology seen by the audience. For example, certain motions such as circling the arms with the controllers has a bigger effect than other motions. So, a majority of Hannah's process involves working with the technology designed by the visualization department in order to find out which movements create a more drastic image.

**Lighting, Costuming, and Music**

The third and final aspect to this process is the lighting, costuming, and music. Sarah Behseresht will work to use these three other aspects that are important in a theatrical stage space to highlight the dancer and the virtual reality technology without detracting from it. The lighting will involve exploring a way for the audience to see a projection on a screen, but also see the dancer behind the screen, creating the pictures with the movements. The costume will correspond with what will look best in the lighting that is chosen. Also, the costume has to

somehow fit the controller inside of it without being noticeable to the audience. The music will also be a very important part of this performance, because some of the cues of the controller will be based off changes in the music, and the choreography will have to rise and fall with the music, or juxtapose the sharp and smooth qualities of the music to make for a more interesting dance.

All three aspects of this research will have to occur harmoniously, so all three of the collaborators will have to work through the decisions and the choreographic process to create an interesting and innovative dance work together.

# SECTION II

# IMPACT OF VIRTUAL REALITY TECHNOLOGY

## History and Advancement of Virtual Reality Technology

The premise of virtual reality is the idea of making a person perceive that they are somewhere that they are not. Virtual reality is able to create realistic environments surrounding its users by incorporating sensations such as sound and imagery. The popularity of virtual reality seems to have taken rise within the last decade into the highly sophisticated and technologically innovative virtual reality we know it as today, but the idea has been around for much longer than that. Artists have been trying to achieve this idea of transporting the viewer to an alternate universe away from reality since the early 19th century ("History of Virtual Reality," n.d.). The artists' method of creating new environments to capture the audience's attention consisted of paintings with panoramic views, incorporating shading and highlighting to detail certain objects while others were less noticeable, and artistic techniques that focused on depth portrayal.

The first attempt in history of transforming a viewer to a virtual reality was completed by Sir Charles Wheatstone in 1838 with the invention of the stereoscope. This invention was later popularized by Oliver Wendell Holmes in 1881 ("Stereoscope," n.d.). The idea of the stereoscope is that there was a pair of goggles that the viewer could put on and see a scene through the lenses. There was a slightly different picture in the right eye versus the left eye that allowed for the viewer to see depth and feel like they were actually at the setting of the picture ("History of Virtual Reality," n.d.).The invention of the stereoscope was historic in that it used the idea of binocular vision in order to create a three-dimensional image by increasing the portrayal of depth to its viewers ("History of Virtual Reality," n.d.). This new technology would

prove to be a major advancement within the world of photography at this time, and later lead to the creation of film and motion picture. In 1922 the idea of three-dimensional imagery was also incorporated with the production of "The Power of Love" directed by Harry Fairall and Nat G. Deverich. Based on the concept behind the invention of the stereoscope, Fairall and cinematographer Robert Elder, created a 3D camera, which was used to produce "The Power of Love." This motion picture was the first ever film to be recorded in 3D and premiered worldwide (Radeska, 2016). Since then, the film industry has made major advancements in the incorporation of three-dimensional imagery into the production of movies and has also included other forms of stimulation to audience members by creating 4D pictures as well as added motion within the seats themselves.

Over the next century, with the advancement of the technology and film industries, many artists have explored the idea of how to achieve a more realistic virtual reality experience. In the late 1990's gaming companies such as SEGA and Nintendo attempted to create goggles that could transport the player into the video game they were playing ("History of Virtual Reality," n.d.). Although the technology has increased drastically within the realm of virtual reality in recent years, there are still possible side effects such as disorientation while wearing the goggles. As much as virtual reality is attempting to match the extent of reality, there are numerous aspects that limit the user to experiencing the fullness of a "virtual" reality. Gerig et al. (2018) completed a study including several researchers in Switzerland that looked at comparisons among groups completing reaching movements to look at the accuracy while using virtual reality. Their study used the same virtual reality software used in this research study, the HTC Vive, coupled with a head-mount, handheld controllers, and Valve Lighthouse optical tracking system. Using either a virtual reality headset or only using the software on a screen, the participants with the headset

were able to complete the gestures more efficiently and accurately than the screen group. There are improvements from screen depth technology in attempt to make graphics look 3D, which allows the user to walk through this virtual world with immense accuracy, however virtual reality technology will not match reality until a more in-body experience is created (Gerig at al., 2018).The success of transforming people to a virtual world has been slowly developing over the past century, but with new technology, attempts over the last decade have been proven to be more victorious.

**Virtual Reality in the Dance World**

While technology has been incorporated into dance for years, there has recently been a push with the swells of the audience desires, to participate in performances making them increasingly interactive (Meador, Rogers, O'Neal, Kurt & Cunningham, 2004). This might look like asking for audiences to make decisions which prompts choreography or a set phrase with a specific chosen word. The audience feels as though they are contributing in the performance and therefore feel a connection with the dancers. One way to accomplish this sense of interaction is through virtual reality. For example, in this research, if the audience is able to see what the dancer is seeing in a virtual world, there is reason to believe that they are more attentively drawn overall than if they were to just see her moving on a stage.

Body movement is one of the first areas that gave rise to the motion capture technology of many gaming devices and virtual reality. Dance incorporates the whole body in movement, so is a perfect pair for technology that maps motion. Hegarini et al. (2016) completed a study in which angular movements and velocities were recorded by eight cameras using optical motion capture technology which translated into the ability to create a system that mirrored the user's movement onto a virtual being. This software and analysis allows for many possibilities in

advancing training systems that capture a person's movement. After the individual's movements are recorded, the software system will compare it to what it should be and then provide any feedback or corrections, which then will be used to train the user (Chan et al, 2011). This is a useful training tool to view the body in a unique way and help with advancements in the health and fitness industry. Virtual Reality equipment has recently made its way into the aspect of dance performance, increasing the audience interactions and relationship with the creative process, and will likely make large advancements within the next few years.

Virtual Reality has been able to contribute to media and technology in many ways and is continuing to move forward in its advancement and depth. As the equipment becomes more accessible to the public, it will likely progress towards becoming more prevalent in artistic mediums such as dance. These advancements open up a new realm of opportunity for the creative artist, and merges the worlds of technology and movement.

# SECTION III

# DETAILS OF PRESENTATION VENUE

## Exhibit Details

Our undergraduate creative works research consists of a final live performance incorporating modern movement and virtual reality technology. Therefore, this performance requires a stage space to assemble the technology that is needed and ample space for our dancers to execute the choreography successfully. On March 22, 2018, our research team will be presenting our creative works showcase, “Vive,” in the Physical Education Building in room 207. This presentation will consist of a five minute dance performance, followed by a question and answer discussion with our creative works research members and our cohorts, Jinsil Hwaryoung Seo and Michael Bruner from the Visualization Department at Texas A&M University. Many pieces of equipment needed to be ordered and borrowed from the Visualization Department such as the virtual reality technology including goggles, sensors, and wireless remotes, a computer, projector, and scrim. Our research began with pure experimentation with choreography and the technology by exploring the program and the designs created by the wireless remotes during movement. Lighting, costumes, and music were then specifically selected to enhance the artistic quality of the piece. The lighting of this piece was difficult to set because a scrim is placed in the middle of the stage and there will be dancers both upstage and downstage. Therefore, in the beginning of the piece, the dancer entering the stage will be lit by front lights while downstage and then as she transitions behind the scrim, lights will turn on to light her upstage as well. This process allowed for us to finalize movement ideas and create a set storyline to our creative works presentation. Two dancers, Kali Taft and Sarah Behseresht, will

perform the choreography onstage and one member of our research team, Hannah Juenke, will be working with the program designed by Michael Bruner during the presentation to ensure it is successful. Crew members have also been assigned to specific tasks for the set-up and take down equipment for the presentation

**Assembly of Exhibit**

There are many factors that are involved in the assembly of the virtual reality technology within the stage space. In order to have a successful live performance, each piece of the equipment must be set-up correctly. For example, the main computer must be turned on and connected to the projector, which is located in the audience, by an HDMI cord. This cord must also be taped down on the stage for health and safety of both the dancers and crew in order to prevent a safety hazard. A crew member will be tasked with the operation of the projector before, during, and after the presentation. The sensors that connect to the virtual reality equipment should be placed onstage and opposite from each other diagonally in order to pick up signals from the wireless remotes used by the dancer. The sensors also establish boundaries for the dancer while she is moving, so she is able to determine her location in the space while wearing the virtual reality goggles. Goggles worn by the dancer allow for her to experience the virtual reality environment and observe the designs within the program, which affect the movement patterns in the choreography. This will be controlled by wireless remotes that will be utilized during the performance. These pieces of equipment are responsible for the changes within the program because the dancer's movements affect the design's shape, brightness, color, and movement, which reflect onto the scrim via the projector. The scrim plays an important role during our creative works presentation because it not only serves as a visual display to our audience members, but it also acts as a prop used by the dancers as they transition from "reality"

to “virtual reality.” During the performance, the dancers will breach the scrim that represents the division between the world of reality, and the world of virtual reality. The lighting of the piece was created by our research team and will be controlled by a lighting technician backstage during the performance. All of these factors are necessary for the virtual reality aspect of our presentation and will need to be assembled by our crew.

# SECTION IV

# REFLECTION OF CREATIVE WORKS RESEARCH

Our creative works research began eight months ago when we first began discussing the collaboration between virtual reality and movement in live performance. Christine Bergeron, the director of dance at Texas A&M University, and Jinsil Hwaryoung Seo, an assistant professor with the Visualization Department composed a grant with the Academy for the Visual and Performing Arts to fund the technology required for creating a virtual reality program. At the beginning of this research process, we experimented with the technology, which is composed of a virtual reality headset, two hand-held controllers, a monitor and computer, scrim, and projector. There were several limiting factors that affected our movement, which we had to consider before starting the choreographic process. When choreographing with a prop, it is important to fully understand the props advantages as well as the limitations. The goggles, the hand-held controllers, the scrim, and the cord were all considered props that affected every decision made in the performance. Movement with all of these added materials was quite difficult, but the primary aspect to take into consideration was that the user is unable to use vision and proprioception in space while moving because of the goggles. Vision is specifically important in dance for balance, turning, and traveling through space. Throughout the choreographic process, we had to limit the use of these movements, or figure out different ways to overcome these obstacles. The second prop was the handheld controllers. If they were being held the whole time, the dancer would not be able to do any inversion work on their hands. To overcome this, we attached the sensors to a device that allowed for a strap to be put on so the sensors were able to fit around the wrist and free up the hands to allow for weight bearing movements. This was

also a safety aspect, because if the dancer for some reason lost balance and fell down, the hands would be free to help take the fall instead of having the hands full of the sensors. The next prop was the scrim, which was primarily used as a way to set the scene and display the images, but during the second semester of development, we incorporated the scrim as a prop and explored the scrim and its purpose on stage. We also had choreography lifting up the bottom of the scrim and crawling underneath it to pass through the two different worlds portrayed in the final piece. The last prop was the long cord that is used to attach the headset to the computer in order to display the virtual reality program. Because of the cord, the radius was limited in the amount of freedom the dancer had to move around in. Jumping and changing direction was a challenge, and since the dancer's vision was impaired by the goggles she had to be extremely cognizant of what she was doing, so she would not pull the cord too far.

One idea that arose throughout the creative process was attempting to find a way for the performance to be completely wireless. The original virtual reality headset had a 12 foot cable which attached the headset to the computer. Along the way, a wireless headset was provided for our project, however, the wireless sensors did not adjust accordingly in the space that the performance would be held in. A wireless headset would have given the dancer a benefit in her ranges of movement. While it was a challenge because we assumed that the hindrance of movement would negatively affect the performance, we were able to arrive to the conclusion that sometimes with the incorporation of so many aspects of creation -- such as technology, choreography, lighting and costume -- that less is more.

Our first semester working on this creative works research mostly included weekly meetings with our virtual reality program developer, Michael Bruner, from the Visualization Department. During our meetings, we would explore various ways to move using both the

headset and controllers and how movement affected the display of the program. We discovered that certain motions caused the intensity of the display to become brighter and there were several shapes such as circles that displayed more effectively compared to others. With these ideas in mind, we made sure to include these motions within our set phrase work for the choreography. As we became more comfortable with the technology, we began exploring movement choices and creating a solo piece on Sarah Behseresht. Each of the group members created a brief phrase and as a team, we modified the phrases and put them together to form a choreographic work.

The second semester of working on this creative works research, we already had a strong foundation set of choreography and an understanding of the program, but we realized we needed to continue to refine our work, and create more of a narrative between the technology and our choreography. We added another dancer to the piece, team member Kali Taft, and explored the idea of dimensionality, and what would happen if two worlds came together and lived in the same space. Through the addition of this objective, we found more purpose and meaning to our work, and dove deeper into the realm of choreography and interaction between humans and technology, which was more than just an exploratory curiosity.

Within the community of dance, incorporation of technology has become an extremely relevant and present topic. Not only has technology changed the interaction of performance, but it has opened up questions for further expansion in the future regarding the concept of combining live performance and technology. As choreographers, we are always looking for new ways to stretch the mind and discover fresh approaches to pair with dance to bring modern ideas into the dance world. Stepping out into the forefront of this field was an amazing experience, one that would not have been possible without the LAUNCH program by allowing us to creatively research an area that we would not have experienced otherwise.

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# APPENDIX A

**Photograph of Virtual Reality Program**

Photographed by: Sarah Behseresht